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Description

Coaxial Cable Connector Installable with Common Tools

Cross Reference To Related Applications

[0001] This is a continuation-in-part of United States Utility Patent Application No. 10/604,470, filed July 23, 2003 which is hereby incorporated herein by reference.

Background of Invention

[0002] Field of the Invention

[0003] The present invention generally relates to coaxial cable connectors. More specifically, the present invention relates to a coaxial cable connector with ease of installation features that is installable with reduced connector specific tooling requirements.

[0004] Description of the Prior Art

[0005] Coaxial cable connectors are used, for example, in communication systems requiring a high level of reliability and precision. A connector that is poorly installed may dam-

age equipment, significantly degrade system performance and or lead to premature system failure. Therefore, prior connectors typically include extensive installation instructions that require costly specialized tools specific to each connector.

[0006] One specialized tool for connectors is the jacket stripper. The jacket stripper is used to accurately strip away outer sheathing from the coaxial cable to expose a specified length of outer conductor for electrical contact with the desired surfaces of the connector. If the amount of outer sheathing removed is short, long or non-uniform, the electrical connection and or the environmental seal of the connector to the cable may be degraded.

[0007] Connectors may be used in confined spaces, for example among banks of cables with minimal spacing between them. Confined spaces increase the difficulty of proper connector installation and or interconnection by increasing the time required to make repeated small turns allowed by the confined space when threading the connectors by hand and or with the aid of a wrench. Also, connectors may be installed in exposed locations such as the top of radio towers where installation personnel may be less inclined to properly follow time-consuming installa-

tion procedures.

[0008] Threaded connections on and between connectors are typically tightened using wrenches having the potential for large moment arm force generation that may damage the connector and or associated cable(s). Therefore, use of a torque wrench with a torque setting specific to each connector is often specified by the prior connector installation instructions. Applying the proper torque, for example 15-20 lb-inches, to threaded connections ensures correct electrical interconnection and prevents application of excessive force that may deform or otherwise damage threads, seals and or the relatively soft metal(s) of the cable(s). The torque wrench is a costly and easily damaged tool that the installation personnel may not always have on hand or bother to use correctly, if at all.

[0009] Competition in the coaxial cable connector market has focused attention on minimization of overall costs, including training requirements for installation personnel, reduction of dedicated installation tooling and the total number of required installation steps and or operations.

[0010] Therefore, it is an object of the invention to provide a connector that overcomes deficiencies in the prior art.

Brief Description of Drawings

[0011] The accompanying drawings, which are incorporated in and constitute a part of this specification, illustrate embodiments of the invention and, together with a general description of the invention given above, and the detailed description of the embodiments given below, serve to explain the principles of the invention.

[0012] Figure 1 is a partial cut-away side view of a coaxial connector according to one embodiment of the invention and a coaxial cable for receiving the connector.

[0013] Figure 2 is an external side view of a rear clamp nut according to one embodiment of the invention.

[0014] Figure 3 is a side section view, along line A-A, of figure 2.

[0015] Figure 4 is an end section view, along line B-B, of figure 2.

[0016] Figure 5 is an external side view of a rear clamp nut according to another embodiment of the present invention.

[0017] Figure 6 is a partial cut-away side view of a coaxial connector according to another embodiment of the invention.

[0018] Figure 7 is an end section view, along line A-A, of figure 6.

[0019] Figure 8 is an end view of figure 6.

[0020] Figure 9 is an end view of a finger ring according to the embodiment of the invention shown in figures 6-8.

[0021] Figure 10 is a side view of the finger ring shown in figure 9.

[0022] Figure 11 is an end view of a ramp ring according to the embodiment of the invention shown in figures 6-8.

[0023] Figure 12 is a side view of the ramp ring shown in figure 11.

[0024] Figure 13 is a partial side section view of a connector according to a second embodiment of the invention.

[0025] Figure 14 is an end cross-section view, along line A-A of figure 13.

[0026] Figure 15 is an end view of a coupling nut according to the second embodiment of the invention.

[0027] Figure 16 is a cross-section view of the coupling nut of figure 15.

[0028] Figure 17 is an end view of an inner coupling sleeve according to the second embodiment of the invention.

[0029] Figure 18 is a cross-section view along line B-B of figure 17.

[0030] Figure 19 is a connector end view of a coupling nut assembly according to a third embodiment of the invention.

[0031] Figure 20 is a partial cross-section view along line A-A of figure 19.

[0032] Figure 21 is an isometric view of a coupling nut according

to the third embodiment of the invention.

[0033] Figure 22 is a cross-sectional side view of the coupling nut of figure 21.

[0034] Figure 23 is an external side view of an inner coupling sleeve according to the third embodiment of the invention.

[0035] Figure 24 is a cross-section side view of the inner coupling sleeve of figure 23.

[0036] Figure 25 is an end view of a finger ring according to the third embodiment of the invention.

[0037] Figure 26 is a cross section view along line A-A of figure 25.

DETAILED DESCRIPTION

[0038] As shown in Figure 1, a connector 1 for use with a coaxial cable 5 has a rear clamp nut 10 adapted to fit over an end portion of the cable 5. A sheath 20 of the cable 5 is removed from the end of the cable 5 to expose the outer conductor 15. Threads 25 operate to clamp the outer conductor 15 between the connector body 50, a circular coil spring 31, a thrust collar 33 and a first inner coupling sleeve 26 coupled to the rear clamp nut 10 via an over-tightening protection assembly 24, described herein below, to secure the connector 1 to the cable 5. If the over-

tightening protection assembly 24 feature is not used, the threads 25 may be formed on the clamp nut 10 and the first inner coupling sleeve 26 omitted. Also, the circular coil spring 31 may be omitted and the outer conductor 15 clamped directly between the connector body 50 and the first inner coupling sleeve 26 or the rear clamp nut 10. An inner conductor 27 of the coaxial cable 5 engages an inner contact 30 of the connector 1 that is spaced away from the outer conductor 15 mating surfaces by an insulator 35.

[0039] A cable stripping feature of the connector 1 is demonstrated by Figures 2-4 which show a simplified version of the rear clamp nut 10. The rear clamp nut 10 has a rear clamp nut bore 32 with a first inner diameter D1 at the cable end 28 of the connector 1 adapted to receive the coaxial cable 5 with sheath 20. A smaller second inner diameter D2 of the rear clamp nut bore 32 at a connection end 29 is adapted to receive only the outer conductor 15 of the cable 1.

[0040] A slot 40 formed in the rear clamp nut 10 has a cutting edge 45 at the end of a helical step 47 between the first inner diameter D1 and the second inner diameter D2. When the rear clamp nut 10 is placed over the end of the

cable 5, the sheath 20 bottoms against the helical step and the cutting edge 45. Rotating the rear clamp nut 10 about the cable 5 drives the sheath 20 against the cutting edge 45 which cuts and separates the sheath 20 from the outer conductor 15. The cut portion of the sheath 20 exits through the slot 40 as the rear clamp nut 10 is advanced over the cable 5. The sheath 20 is trimmed to the correct length, for example, when the outer conductor 15 reaches the connection end of the rear clamp nut 10.

[0041] The rear clamp nut 10 may be attached to the connector body 50 via threads 25 shown in detail on Figure 5. The threads 25 comprise four interleaved concentric threads equally spaced from each other along the length of the connector. Each of the four threads has the same lead with thread ends spaced 90 degrees apart from each other around the axis of the connector 1. The interleaved threads 25 have a pitch that is four times normal, resulting in threaded assembly of the connector 1 requiring only one quarter the number of turns compared to a common single thread. Because the threads 25 are interleaved, the threads maintain the same overall thread to thread contact area resulting in a thread 25 with strength comparable to common single threading but with a pitch

that is increased by a factor of 4. In alternative embodiments, use of two or three interleaved concentric threads will result in a one half or one third reduction, respectively, in the number of turns required to attach the rear clamp nut 10 to the connector body 50. Flats 55 formed in the outer surface of the rear clamp nut 10 and connector body 50 provide tool surfaces for the tightening of rear clamp nut 10 against the connector body 50.

[0042] One or more over-tightening protection assembly(s) 24 of the connector 1 prevents damage from over tightening of the coupling nut 54 and or rear clamp nut 10 to the coupling nut 54, connector body 50, rear clamp nut 10 (if present), threads, seals and or the relatively soft metal(s) of the cable(s). A separate over-tightening protection assembly 24 may be applied to operate with respect to the threads 25 and the connector threads 56, each with a separate desired torque rating.

[0043] The over-tightening protection assembly 24 is first explained with the aid of a simplified version of connector 1, as shown in figures 6-8, having an over-tightening protection assembly 24 in the coupling nut 54. The coupling nut 54 has an aperture dimensioned to accept a second inner coupling sleeve 60. The second inner coupling

sleeve 60 has connector threads 56 located on an inner diameter 59 for coupling with other connectors and or equipment. Where the mating threaded surface is similarly configured, the connector threads 56 may be multiple interleaved concentric threads as described herein above. The second inner coupling sleeve 60 may be retained upon the connector body 50 in a rotatable configuration by an inward protruding coupling sleeve flange 61 that overlaps a corresponding outer protruding interface flange 62 of an interface 63 that is, for example, press fit into the cable end 28 of the connector body 50.

[0044] One skilled in the art will appreciate that an over-protection assembly 24 may likewise be incorporated in the rear clamp nut 10 as shown in figure 1.

[0045] Where the over-tightening protection assembly 24 is implemented with respect to the rear clamp nut 10, the description herein below with respect to the second inner coupling sleeve is similarly applied to the first inner coupling sleeve 26 or the like.

[0046] Rotation of the coupling nut 54 is coupled, within a selected torque range, to the second inner coupling sleeve 60 by a first interlock surface coupled to the coupling nut 54 and a corresponding second interlock surface coupled

to the second coupling sleeve 60, the first interlock surface and the second interlock surface having complementary protrusions. Here, the first and second interlock surfaces are formed in a finger ring 65, as shown for example in figures 9 and 10, and a ramp ring 70, as shown for example in figures 11 and 12. The finger ring 65 and the ramp ring 70 are located coaxially within a step or groove 52 formed in the coupling nut 54.

[0047] The finger ring 65 may be keyed to the coupling nut 54 by a plurality of first ring tab(s) 75 distributed around the inner diameter of the groove 52 which interlock with corresponding finger ring slot(s) 76 in the finger ring 65. Similarly, the ramp ring 70 may be keyed to the second inner coupling sleeve 60 by a plurality of inward projecting second ring tabs 77 that couple with inner coupling sleeve slot(s) 78 formed in, for example, a cable end of the second inner coupling sleeve 60. Finger(s) 80 projecting inward from the finger ring 65 engage the ramp(s) 85 extending outwards from the ramp ring 70.

[0048] Rotation of the coupling nut 54 is transmitted to the second inner coupling sleeve 60 for threading of the connector threads 56 until a predetermined torque value is reached whereupon the finger(s) 80 of the finger ring 65

and or the ramp(s) 85 of the ramp ring 70 momentarily deflect / deform and slip past the ramp ring 70 or vice versa, preventing application of out of range torque levels to the second inner coupling sleeve 60 and thereby to the connector threads 56, gaskets and or the relatively soft metal(s) of the cable(s). During reverse rotation, the finger(s) 80 impact a step side of the ramp(s) 85 having an increased angle ensuring that increased torque levels sufficient to enable unthreading of the connector 1 may be applied.

[0049] The torque value at which the finger ring 65 slips past the ramp ring 70 may be adjusted, for example, by selecting materials with desired bending/deformation characteristics; adjusting the angles of the mating surfaces of the finger(s) 80 and or ramp(s) 85; and or modifying the thickness of the selected material(s). The finger ring 65 and or the ramp ring 70 may be formed using a wide range of techniques including, for example, machining, metal stamping, bending and ring rolling of metallic stock or injection molding from a material such as plastic, nylon, polycarbonate, ABS or the like. The positions of the finger and ramp ring pairs may be switched and or either or both of the first and second rings replaced with other

forms of complementary protrusions and or interlocking structures of which at least one of a complementary pair will temporarily or permanently deflect / deform and release the connector body 50 to second inner coupling sleeve 60 interlock when the applied rotation torque reaches a desired threshold level. For example, interlocking protrusions, bumps, arches and or leaf springs may be used with an equivalent effect according to the invention.

[0050] The overall size of the resulting assembly, manufacturing operations and total number of components may be reduced by incorporating the second inner coupling sleeve 60 or coupling nut 54 with the finger ring 65 and or ramp ring 70 interlocking protrusion(s) functionality. As shown in a second embodiment using a metal finger ring 65, demonstrated by figures 13-18, like elements similarly notated, the ramp(s) 85 are integrated with the second inner coupling sleeve 60. The coupling nut 54, as shown in figures 15 and 16 again uses a plurality of first ring tab(s) 75 to rotatably interlock with finger ring slot(s) 76 of a finger ring 65, as shown in figures 9 and 10, dimensioned for press fitting within the groove 52.

[0051] In the second embodiment, the second inner coupling sleeve 60, as shown in figures 17 and 18 is retained

within the coupling nut 54 by a lip edge 87 formed around a connector end 29 of the second inner coupling sleeve 60. The lip edge 87 snaps into and is rotatably retained within a corresponding coupling sleeve retention groove 89 as the second inner coupling sleeve 60 is inserted within the coupling nut 54.

[0052] As shown by figures 19-26, a third embodiment demonstrates, for example, adaptations for a finger ring 65 formed from a plastic material. The finger ring 65 has a simplified mounting within the groove 52 via a plurality of first ring slot(s) 90 formed around a cable end 28 of the coupling nut 54 which receive corresponding outwardly projecting fin(s) 91 of the finger ring 65. To allow for the lower strength available from plastic material, the number of finger(s) 80 and corresponding ramp(s) 85 may be increased. The lip edge 87 may be formed using a plurality of individual tine(s) 93 formed at the connector end of the second inner coupling sleeve 60.

[0053] The connector 1 may be adapted to mate with the dimensions and configuration of a specific coaxial cable 5, for example a coaxial cable with annular or helical corrugations in the inner and or outer conductors 27, 15. Further, the connector end of the connector 1 may be adapted to

mate according to male and or female embodiments of a proprietary interface or any of the standard connector types, for example Type-F, BNC, Type-N or DIN.

[0054] The present invention provides coaxial connectors with ease of installation features and reduces specialized installation tool requirements. The sheath stripping cutting edge slot eliminates the need for a dedicated sheath stripping tool and strips the sheath to the correct outer conductor exposure during connector assembly without requiring a separate stripping step. Interleaved threads allow the connector to be installed with a significantly reduced threading requirement. Also, protection from damaging excess torque application during connector installation and elimination of the need for torque wrenches may be built into the connector.

[0055] One skilled in the art will appreciate that the torque limiting coupling nut assemblies described herein may also be used in other, non-connector, applications where a torque limiting function is desirable. By removing the inner coupling sleeve flange 61, the torque limiting coupling nut assembly may be used as a replacement for any common threaded nut, providing the benefit of torque limitation to any threaded interconnection. For example, where nuts

and bolts are used to secure glass panels and mirrors, torque limiting nuts according to the present invention may be used to limit the compression applied as the nut is tightened upon the bolt and thereby upon the glass panel.

[0056] Table of Parts

1	connector
5	coaxial cable
10	rear clamp nut
15	outer conductor
20	sheath
24	over-tightening assembly
25	threads
26	first inner coupling sleeve
27	inner conductor
28	cable end
29	connector end
30	inner contact
31	circular coil spring
32	rear clamp nut bore
33	thrust collar
35	insulator
40	slot
45	cutting edge
47	step

50	connector body
52	groove
54	coupling nut
55	flats
56	connector threads
59	inner diameter
60	second inner coupling sleeve
61	inner coupling sleeve flange
62	interface flange
63	interface
65	finger ring
70	ramp ring
75	first ring tab
76	finger ring slot
77	second ring tab
78	inner coupling sleeve slot
80	finger
85	ramp
87	lip edge
89	coupling sleeve retention groove
90	first ring slot
91	fin
93	tine

[0057] Where in the foregoing description reference has been made to materials, ratios, integers or components having known equivalents then such equivalents are herein incorporated as if individually set forth.

[0058] While the present invention has been illustrated by the description of the embodiments thereof, and while the embodiments have been described in considerable detail, it is not the intention of the applicant to restrict or in any way limit the scope of the appended claims to such detail. Additional advantages and modifications will readily appear to those skilled in the art. Therefore, the invention in its broader aspects is not limited to the specific details, representative apparatus, methods, and illustrative examples shown and described. Accordingly, departures may be made from such details without departure from the spirit or scope of applicants general inventive concept. Further, it is to be appreciated that improvements and/or modifications may be made thereto without departing from the scope or spirit of the present invention as defined by the following claims.